Language contact phonology: Richness of the stimulus, poverty of the base*

Ellen Broselow

Stony Brook University (State University of New York at Stony Brook)

1. The Problem: Learnability of interlanguage rankings

The goals of Optimality Theory are not only to model the speaker's grammar but also to model the process whereby one aspect of that grammar, the language-specific rankings of constraints, is acquired. The framework forces us to ask not only what constraint rankings describe the data of a language, but also how those rankings could have been learned.

The focus of this paper is cases in which the second question is not so easily answered. Language contact situations confront speakers with types of structures that are not found in their native language, and in these situations we often find systematic adaptation patterns that are fairly consistent across speakers of the same native language. The analysis of such patterns may require fairly intricate webs of constraint rankings, and often, neither the data of the native or the foreign language provide sufficient motivation for these rankings. One possible explanation of such apparently unmotivated rankings is that they reflect the universal default. If this is the case, we should expect the same rankings to emerge in all situations where evidence to the contrary is lacking. But as Peperkamp (2003) has argued, there appears to be cross-linguistic variation in adaptation patterns that cannot be attributed to the data of either of languages in contact. This leaves us with a puzzle: if we find interlanguage rankings that are a product neither of universal grammar nor of input data, what is their source?.

In this paper I will argue that the need for apparently nonlearnable rankings disappears once we recognize the role of input frequency, and the role of the principles that determine the mapping of the acoustic signal onto phonological representations. First, a ranking algorithm that connects the frequency of violation of a constraint with its rate of demotion (such as the GLA of Boersma and Hayes 2001) will give rise to emergent rankings that are in fact motivated by data (Broselow, to appear). And second, what appear to be

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unmotivated rankings of production constraints may actually be better described as an effect of the native language perception/decoding grammar, which interprets the acoustic signal in terms of the native language system. If we assume that the perception grammar defines which aspects of the acoustic signal are linguistically significant, causing listeners to disregard certain aspects of the contact structures, many interlanguage adaptations can be seen as simple effects of interference from the native language grammar. In this bipartite model, the inventory of structures presented by the contacting language is often richer than that presented by the native language input (the richness of the stimulus). But the listener's perception grammar maps this input onto a more restricted set of phonological representations (providing the adapter with an impoverished base, or set of underlying representations).

The paper begins with a survey of several types of ranking puzzles in language contact, followed by consideration of the sorts of rankings that we would expect to find in language contact phonology. I then consider three examples of the adaptation of stress in borrowed words. In Huave, loans from Spanish both preserve Spanish stress and obey the Huave stress restrictions; where these two goals conflict, the tension is resolved by deletion of source segments. In contrast, Selayarese adapters give faithfulness to native segments priority over maintaining source stress where it conflicts with the native stress patterns. And in Fijian, source stress is preserved while source vowel length may be altered. These different adaptation patterns have been described in the literature in terms of different rankings of a production grammar constraint MatchStress (or MaxStress) directing that the position of the source stress should be maintained. But because this constraint is specific to learnwords, it is not clear how the early adapters could have learned its ranking. The proposal of this paper is that the maintenance of source stress is not a function of the production grammar at all, but rather is determined by the native language perception/decoding principles which determine how foreign language stress is interpreted.

2. Ranking Puzzles in Language Contact Phonology

In the OT model of phonological acquisition, the initial state involves a set of constraints which are either unranked, or in which there is a bias toward ranking markedness constraints above faithfulness constraints, ensuring that learners begin with the most restrictive grammar (Hayes 1999, Tesar and Prince 1999). The learner establishes a ranking based on input from the ambient language. The input data may not be sufficient to establish an exhaustive ranking of all constraints, in which case the final state of the grammar could conceivably impose only a partial ranking (Ross 1996, Anttila 1998), or learners could choose an arbitrary ranking of otherwise unrankable constraints (Tesar and Smolensky 2000); in the latter case, we need not assume that all learners would arrive at the same rankings. Given these assumptions, we can identify the following possible ranking patterns in the interlanguage grammar (the grammar that accounts for systematic behavior in loan adaptation and/or second language acquisition):

(1) Possible ranking patterns in SLA or loan adaptation:
a. M >>F: putative default pattern
b. F >> M: motivated by marked forms
c. M >>M, F>>F: mysterious if not motivated by data

While M>>F rankings, as the default, need not be motivated by data, the other rankings are data-driven. But examination of language contact phonology reveals many examples of rankings that are not obviously motivated by data other than language contact data:

1. Differential Difficulty (M>>M): In this case, one foreign language structure is mastered more quickly than another, even though neither appears in the native language. One example of this pattern from second language acquisition involves final obstruent devoicing, which is attested for a number of speakers whose native language (such as Mandarin Chinese and Tswana) allows no obstruent codas of any type, and whose target language allows both voiced and voiceless obstruent codas (Wissing and Zonneveld 1996, Grijzenhout and van Rooij 2000, Eckman 1981, Flege and Davidian 1984, Flege, McCutcheon, and Smith 1987, Yavas 1994, Broselow, Chen, and Wang 1998, Xu 2003, Broselow, to appear). The M>>M pattern also underlies much of the evidence for lexical strata, analyzed by Ito and Mester (1995) as involving subgrammars specific to core and peripheral vocabularies.

2. Differential faithfulness (F>>F): In this case, certain aspects of contacting structures are preserved while others are lost. Thus, as discussed below, in borrowings from Spanish into Huave, the stress of the source word is preserved at the price of segmental unfaithfulness (Davidson & Noyer 1996), while in borrowings from Bahasa Indonesia into Selayarese, the source segmental structure is preserved while the source stress may be lost (Broselow 1999). Some F>>F rankings might be explained as the reflection of a universal perceptual similarity hierarchy (Steriade 2000), but not all cases are consistent with a universal ranking.

3. Differential repair strategies (F>>F or M>>F): In this case, the source language presents adapters with two or more structures that are equally impossible in the borrowing language, yet speakers use distinct repair strategies in adapting them. For example, in Wolof borrowings from French, obstruent-sonorant onsets are repaired by a copy vowel inserted between the two consonants ([kalas] from French [klas] 'class'), but [s]-stop onsets are repaired by insertion of a default vowel before the two consonants ([estati] from French [staty] 'statue,' Broselow 1992, Fleishhacker 1999). Since Wolof has no complex onsets of either type, the native language provides no basis for distinguishing them.

4. Ranking reversals (C1>>C2, C2>>C1): Many of the preceding cases involve rankings that are not motivated by the native language data, but are at least not inconsistent with it. In other cases, interlanguage patterns require an actual reversal of the rankings of the native language, even though the contacting language does not appear to present evidence for the new ranking. Thus in Malayalam, single voiceless consonants do not occur intervocalically. In Malayalee English, English intervocalic voiceless stops are realized as voiceless geminates (Ident(voice)>> Ident(mora)) although in Malayalam, length distinctions are preserved in preference to voicing distinctions (Ident(mora)>>Ident(voice), Mohanan and Mohanan 2003).

Various possible sources of 'hidden' ranking effects (Davidson 2000) include an the role of frequency in the data (Broselow, to appear); the native speaker's articulatory program (Ussishkin & Wedel, to appear); and the role of perception (Silverman 1992, Yip 1993, Kenstowicz 2001, 2003, Kang 2003, Peperkamp 2003). The claim of this paper is that all (non-default) rankings are learnable from the data, either as rankings that emerge from input frequency, or as an effect of the native language perception grammar.

In the next three sections I consider three cases of loan adaptation differing in the extent to which source language stress is preserved, and in the sorts of unfaithfulness that are tolerated to facilitate stress preservation. All three cases have been analyzed in the literature terms of ranked constraints, and in two cases, a production grammar constraint MatchStress (or MaxStress), which applies only to borrowed words, plays a central role. The postulation of a MatchStress constraint, along with the assumption that constraints can be freely ranked across languages, predicts a wide variety of possible loan adaptation patterns. I will argue that there is no MatchStress constraint operating in loan adaptation. Instead, whether or not the source stress is maintained in loanwords is a function not of the rankings of production grammar constraints, but rather of the role played by stress in the native language.

3. Stress Adaptation in Huave

3.1. Production Grammar Analysis of Huave Adaptations

The Penutian language Huave has borrowed a number of words from Spanish. Huave restricts stress to one of the two final syllables of the word, while Spanish words may have stress on any one of the three final syllables, creating conflicts between the Huave stress restrictions and the actual source stress. Davidson and Noyer (1996) analyze the Huave adaptation patterns in terms of ranked constraints of the production grammar, and some of the rankings they posit are not obviously motivated by either the Huave or the Spanish data.

In Huave native vocabulary, stress falls on a final closed syllable, and on the penultimate syllable when the final is light. Huave has no vowel length contrast, so syllable weight is dependent on the presence or absence of a coda consonant. Words have a single stress, with the exception of words with multisyllabic clitics, where a secondary stress falls on the root-final syllable (Kreger and Stairs 1981, page xvii). Because all stems of major lexical categories and all suffixes end in a consonant, final stress is the overwhelmingly predominant pattern in Huave.

(2) Huave native vocabulary (Kreger and Stairs 1981):

a. aráŋ	'hace, he does'
b. taraŋás	'hice, I did'
c. taraŋasán	'hicimos, we did'
d. ʃíke	'I'

To describe the Huave facts, Davidson and Noyer posit the following constraints, each apparently undominated in the native grammar:

(3) Huave Constraints
a. TrochaicFeet: Feet are bimoraic trochees ([‘CVCV] or [‘CVC])
b. Align-R: Right Prosodic Word Edge = right edge of a foot
c. Free-V: *V]word

Interestingly, these three constraints show different degrees of strength in borrowed words. The most nativized vocabulary items maintain the Huave pattern of final stressed and closed syllables, while still preserving the Spanish stress--if necessary, by deletion of segmental material in the final syllable of the source:

(4) Loans into Huave from Spanish, Stratum 1 (most nativized)

Spanish	Huave	
garabáto	garabát	‘hook’
kardúmen	kardúm	‘flock’
márso	márs	‘March’

Davidson and Noyer attribute the maintenance of Spanish stress to a constraint MatchStress which is, along with Huave stress constraints and Free-V, ranked above segmental faithfulness constraints in the core stratum:

(5) Match(Stress): Stress falls on the same vowel in the source word as in the loan word (Davidson and Noyer 1996, page 69).

(6) Stratum 1 /garabáto/	Match Stress	Trochaic Feet, Align-R	Free-V	Max
a. gara[báto]			*!	
☞b. gara[bát]				*

While the native vocabulary appears not to provide evidence for any ranking of Free-V with respect to the stress constraints, the second stratum of more peripheral loanwords respects the stress constraints but not Free-V:

(7) Huave from Spanish, Stratum 2:

Spanish	Huave	
gwanábana	gwanába	‘sweet-sop’
mandádo	mandáda	‘command’

The facts of this less nativized stratum can be described by assuming a second subgrammar in which the segmental faithfulness Max constraint, while still dominated by the Huave stress constraints, is ranked above Free-V:

(8) Stratum 2 /gwanábana/	Match Stress	Trochaic Feet, Align-R	Max	Free-V
a. gwa[nába]na		*!		
b. gwana[bána]	*!			
☞c. gwa[nába]			*	*
d. gwa[náb]			*!*	

And finally, the third stratum of least nativized loanwords exhibits violations of both native stress constraints and Free-V, while still preserving the Spanish stress:

(9) Huave from Spanish, Stratum 3 (least nativized):

Spanish	Huave	
myérkoles	myérkoles	'Wednesday'
médiko	médiko	'doctor'

(10) Stratum 3 /médiko/	Match Stress	Max	Trochaic Feet, Align-R	Free-V
☞ a. [médi]ko			*	*
b. [médik]		*!		

Although both apocope (*garabát* from *garabáto*) and non-trochaic stress (*médiko*) are possible in loans, there are no cases in which both cooccur in a single form (**médik*). This prohibition arises, Davidson and Noyer argue, from the basic ranking MatchStress >> TrochaicFeet, Align-R >> Free-V. The three possibilities (consonant-final words with final stress in the core vocabulary; consonant-final words with final stress and vowel-final words with penultimate stress in less nativized vocabulary; and antepenultimate stress in peripheral vocabulary) arise from the differential ranking of the anti-deletion Max constraints with respect to MatchStress and the markedness constraints. The Huave data are therefore consistent with Ito and Mester's (1995) claim that while faithfulness constraints can be ranked differently in the subgrammars associated with different lexical strata, the relative rankings of markedness constraints are held constant across strata.

Additional complications ensue when we consider the treatment of Spanish complex onsets (forbidden in native Huave vocabulary), which are simplified by means of vowel insertion:

(11) brasáda barasáda 'unit of measure' (*basáda, *sáda)

It is striking that while entire syllables may be deleted to preserve Spanish stress (*gwanába(na)*), insertion, rather than deletion, is the strategy used to avoid complex onsets. Davidson and Noyer elegantly describe these facts by ranking MatchStress and Max(C,V) over *ComplexOnset, in turn ranked over Dep(V). This ranking makes vowel insertion the preferred repair strategy where there is a choice (as in the resolution of a complex onset violation). But the mandate that stress may neither leave its original syllable nor fall to the left of the penultimate syllable rules out vowel insertion as an option in posttonic position. Again, however, we must wonder how the original Huave adapters might have come up with such a ranking, in the absence of any evidence for either consonant deletion or vowel insertion in Huave. Thus, this analysis raises a number of thorny questions concerning the learnability of the constraint rankings:

1. Why would Huave speakers rank stress constraints over Free-V (M>>M)? This ranking describes the fact that adapters give up the requirement that words end in consonants before they give up the requirements that the stress foot be aligned with the right edge of the word. But what would motivate such a ranking, when both the stress constraints and Free-V are uniformly obeyed in Huave (for content words), and frequently violated in Spanish?[1]

2. Why would Huave speakers rank MatchStress over Max? This ranking describes the preservation of the source stress position at the cost of deleting source segments. But the Huave input provides no evidence for this ranking-- nor could it, since the MatchStress constraint refers specifically to borrowed words. MatchStress could be argued to be an output-output constraint, a type which Hayes (1999) has argued is ranked high by default. But if we assumed that stress preservation is an effect of a high ranked (by default) O-O constraint, we should then have to explain why O-O constraints on faithfulness to stress outrank O-O constraints on segmental faithfulness. This pattern of faithfulness to stress over faithfulness to segments is not universal, as we shall see in the discussion of Selayarese below.

3. Why would Huave speakers arrive at the ranking MatchStress>>Max(C) >> *ComplexOnset>>Dep(V) (M>>F>>M>>F), which describes the use of segment deletion to resolve stress violations but the use of vowel insertion to resolve complex onset violations? It is difficult to see how speakers would arrive at this particular ranking in the absence of evidence for the relative rankings of constraints against deletion or insertion in either Spanish or Huave data.

3.2. Alternative Analysis of Huave Adaptations

In this section I argue that what appear to be the effects of apparently unlearnable constraint rankings in Huave loan adaptation are actually either input frequency effects or effects of the native language perception grammar–specifically, the grammar that maps the acoustic signal to phonological representations.

Let us first consider the ranking of stress constraints over Free-V. The evidence for this ranking is just the adaptation facts: Stratum 1 words obey both stress constraints and Free-V, while Stratum 2 vocabulary obeys only the stress constraints. But why would Huave

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[1] I assume that Huave speakers distinguish content and function words, and that the presence of vowel-final function words in Huave would not contribute to demotion of Free-V. See Peperkamp 2004 for arguments that even infants distinguish content and function words, and that basic generalizations about stress are not disrupted by function words that interfere with general patterns.

speakers set up such a ranking, given that Huave words obey both?

An examination of the Spanish data reveals, however, that while Spanish words may violate both the Huave stress constraints and Free-V, they do so with differing degrees of frequency. Eddington (2000) finds, among the 4,829 most frequent Spanish words, 2,850 vowel-final (59%) and 1,979 consonant-final words (41%). Therefore, the majority of Spanish words contribute to demotion of Free-V. Because Free-V appears to be demoted more quickly in the interlanguage grammar than the stress constraints, we expect that the percentage of Spanish words consistent with Free-V should be smaller than the percentage consistent with the Huave stress constraints. This is borne out by the corpus data. 798 (16.5%) of the consonant-final words in Eddington's corpus have final stress, while 2494 (51.6%) of vowel-final words have stress on the penultimate syllable. Therefore, about 68% of the most frequent Spanish words conform to the Huave stress restrictions. Only 274 (5.6%) have antepenultimate stress, violating Align-R, while 1085 (22.4%) are consonant-final with penultimate stress and 178 (3.6%) are vowel-final with final stress:

(12) Percentage of Spanish words consistent with Huave constraints
a. stress constraints: 68%
b. Free-V: 41%

If we assume a ranking algorithm that is sensitive to the frequency of input structures, such as the Gradual Learning Algorithm (GLA, Boersma and Hayes 2001), the ranking of stress constraints over Free-V will emerge from exposure to Spanish data. In the GLA, which assumes stochastic constraint rankings, the rate at which a constraint is demoted is proportional to the frequency with which it is violated: more frequently violated constraints are demoted more quickly than less frequently violated constraints. Thus, this ranking is indeed learnable from the data, as a function of the relative frequency of violating structures in the foreign data.[2]

We now turn to the question of why Huave speakers value the preservation of source stress over the preservation of source segments, encoded by Davidson and Noyer as a ranking of MatchStress over Max. I propose that in fact, the loss of posttonic segments in loans from Spanish is not an effect of the production grammar at all, but rather an effect of a high-ranked perception grammar constraint:

(13) Perception Grammar constraint:
AssumeWordEdge-R: in mapping the acoustic signal to
underlying representations, assume a word edge following each stress foot.

[2] See Levelt & van de Vijver 1998, Boersma & Levelt 1999 for similar arguments from L1 acquisition. Also see Broselow, to appear and Xu 2003 for similar arguments for final devoicing in second language acquisition, as well as for discussion of alternative analyses, e.g.., final devoicing as default ranking of positional faithfulness constraints, articulatory program, or misperception.

This constraint, presumably one that Huave children internalize fairly early, will direct listeners to assume that material following the stress foot is either part of the following word, or noise without linguistic significance. (An example of such nonsignificant articulation would be a labial closure following a phrase-final vowel, coincident with simply shutting the mouth. Phonologization of such labial closure is probably responsible for the final consonant in English 'nope.') For Huave, AssumeWordEdge is undominated, and serves as a filter on possible phonological representations. However, like all constraints, its ranking is a function of input data. Provided with enough evidence that a high ranking of this constraint is inconsistent with the ambient data, the listener will demote this constraint (as has presumably happened in the grammars of Huave speakers who produce nonnativized forms like *médiko*).

The perception constraint helps us to understand why apocope is always accompanied by trochaic stress (**médik*) in Huave loan adaptation, described by Davidson and Noyer as the a reflection of the production grammar ranking TrochFeet>>Max >>Free-V. In the listener-oriented account, apocope is a function of misparsing, not of the production grammar. Once the parsing constraint AssumeWordEdge is demoted below constraints that allow the possibility of antepenultimate stress, we no longer expect apocope. Similarly, the asymmetry in pretonic and posttonic repair tactics, illustrated by vowel insertion in forms like *barasáda* (Spanish *brasáda*) but deletion in forms like *gwanába* (Spanish *gwanábana*), is unsurprising. The perception grammar of Huave listeners directs them to disregard material following the stress foot, but material preceding stress is potentially contrastive, and must be preserved.

On this account, then, the analysis of Huave loan adaptation requires no unlearnable rankings, and no MatchStress constraint. The greater strength of the native language tendency to right-aligned stress vs. the tendency to end words in consonants emerges as a function of the greater frequency of Spanish vowel-final words than of Spanish words violating Huave stress constraints. The deletion of segments in poststress position is a function of the perception/parsing grammar, which by projecting a word edge after the stress will map a Spanish form like *garabáto* onto an underlying representation /*garabat*/. The asymmetry between posttonic and pretonic positions in terms of repair strategy also follows from the interaction of the perception grammar and the production grammar: material is lost in positions where the perception grammar defines it as not significant (or not part of the relevant morpheme), while it is preserved where the grammar defines it as contrastive. The perception grammar acts as a filter, mapping structures that are potentially contrastive in the foreign language (V'C#, V'CV#, V'CVC#, etc.) onto a single underlying representation. These underlying representations then serve as inputs to the production grammar.

The listener-oriented account of Huave adaptations makes quite different typological predictions from an account incorporating a MatchStress constraint into the production grammar. Inclusion of MatchStress in the universal constraint set, along with the hypothesis that constraints may be freely ranked, places no limits on the number of possible combinations of stress preservation in loans and stress function in the native language. In contrast, an account that ties stress preservation to the native language perception grammar leads us to expect that languages with a less consistent relationship between stress and word structure should be freer to disregard the source stress. We now turn our attention to such a language.[3]

4. Stress Adaptation in Selayarese

In many ways, the stress system of Selayarese is quite similar to that of Huave; both languages prefer a trochaic foot at the right edge of the word (ranking TrochaicFoot and Align-R(word,foot) high), and both lack phonemically long vowels. They differ in the composition of the stress foot: in Selayarese, codas do not contribute to syllable weight, so all feet are bisyllabic, yielding penultimate stress:

(14) Selayarese native stress (Basri1999, Broselow 1999)

sam[púlo]	'ten'
[bálaŋ]	'creek'
kali[hára]	'ant'

Selayarese has borrowed a large number of words from Bahasa Indonesia (BI). While many BI words also have penultimate stress, the BI prohibition on stressed schwa leads in some cases to final stress. As the forms below illustrate, Selayarese borrowers ignore the source stress of BI words, assigning them stress according to Selayarese restrictions. (Because Selayarese lacks schwa, BI schwa is realized as a full vowel in Selayarese, though the quality of this vowel is not entirely predictable. For discussion of the segmental changes motivated by Selayarese segmental and syllable structure restrictions, see Basri 1997, Broselow 1999).

(15)

Bahasa Indonesia	Selayarese	
gəmúk	[gómmoʔ]	'fat'
sədəkáh	si[dákka]	'alms'
səbáb	[sábaʔ]	'cause'
bənáŋ	[bánnaŋ]	'thread'

The Huave strategy of deleting posttonic material would obviously not be viable for Selayarese speakers, since their goal is penultimate stress. However, Selayarese speakers could in principle use vowel insertion to bring loan words with final stress into conformity with the native stress restrictions-- as they in fact do with borrowed subminimal forms, such as *bom* 'bomb,' which is realized as *bóʔoŋ*. It is not obvious why BI *bənáŋ*, for example,

[3] Peperkamp and Dupoux (2002) argue that adult speakers of languages like Huave, in which stress is invariably utterance-final, exhibit 'deafness' to stress in other languages, manifested in their difficulty in distinguishing CVCV words differing only in the position of stress (as contrasted with their ability to perceive segmental contrasts in such words). These results appear to be inconsistent with our claim that Huave speakers use stress to determine word structure. But in the experimental paradigm, unlike in language contact, listeners were presented with already segmented 'words'.

should not also be realized with vowel insertion (**banáʔaŋ)*, which would both preserve the source stress and place it in the normal Selayarese penultimate position. But insertion of segments is used only in monosyllabic words; in longer words, Selayarese speakers simply shift the original stress to the normal Selayarese position (*bánna*ŋ).[4] We can describe this pattern by the ranking TrochaicFoot, Align-R >> DEP >> MatchStress (if MatchStress is part of the grammar of Huave, it must be part of the grammar of all languages). The ranking TrochaicFoot>>DEP is consistent with the facts of Selayarese, which indeed has no words smaller than two syllables. But the ranking of MatchStress would need to be explained.

We see the same disregard for source stress in another class of words. Many Selayarese roots end in [r], [l], or [s], none of which is a possible coda (Mithun and Basri 1986, Broselow 1999). When one of these consonants occurs in root-final position, it is followed by a copy of the preceding vowel. Words with a final epenthetic vowel take stress on the antepenultimate syllable:

(16)	[lámbe]re	'long'
	[sússu]lu	'burn'
	maŋ[kása]ra	'Makassar'
	[sáha]la	'profit'

Note that the epenthetic vowel fails to appear before a vowel-initial (nonclitic) suffix (cf. *lámbere/lambéra*ŋ 'longer'), in contrast to underlying vowels, which always appear (*tirére/tireré-a*ŋ 'thirsty/thirstier').

This association of antepenultimate stress with a final epenthetic vowel in native vocabulary has been analyzed by ranking Head-Dep, which directs that an epenthetic vowel may not be part of the main stress foot (Alderete 1999) above Align-R. This ranking favors the formation of a bisyllabic foot containing only underlying vowels over the formation of a perfectly right-aligned foot:

(17) Head-Dep: Stress foot includes only underlying vowels (Alderete 1999)

/lamber/	Head-Dep	Align-R
a. lam [bére]	*!	
☞b. [lámbe] re		*

This pattern is also respected in loanwords, which take antepenultimate stress with a final epenthetic vowel, regardless of the stress of the source:

(18)	Bahasa Indonesia	Selayarese	
	sénter	[sénte]re	'flashlight'
	kəlás	[kála]sa	'class'
	bərás	[béra]sa	'rice'
	bələbás	ba[lába]sa	'ruler'

[4]The one exception is *koráʔa*ŋ 'Koran' (Hasan Basri, personal communication). Clearly, there are sociolinguistic factors that could mandate greater faithfulness in this case.

The Selayarese speakers could easily have preserved the source stress by adapting BI *kəlás* (for example) as **kalása* rather than *kálasa.* There would be nothing objectionable in the surface form **kalása;* as the minimal pair *sáhala* 'profit' (from root /sahal/) and *sahála* 'sea cucumber' (from /sahala/) shows, the presence of [r,l,s] surrounded by identical vowels is a necessary but not a sufficient condition for antepenultimate stress.

Again, we could describe this pattern by a production grammar ranking Head-Dep, TrochaicFoot >> Align-R, Dep >> MatchStress. But again, it is not clear what would cause speakers to converge on this ranking; as we know from the Huave case, low ranking of MatchStress is not universal. Let us look at these facts, then, from the standpoint of the Selayarese listener.

While stress serves unambiguously in Huave to mark word edges, the role of stress in Selayarese is not so straightforward. Clearly, the epenthetic forms muddy the relationship between stress and word edges. An additional complicating factor is the presence of clitics, which fall outside the stress domain, though they still participate in certain aspects of word-level phonology (Basri et. al, 2000).

(19) [géle] -ma - kaŋ 'we are no longer...'

Clitic attachment may result in stress as far back as the preantepenult. Therefore, a sequence of three syllables, only the first of which is stressed, could correspond to any of the following morphological structures in Selayarese (though the interpretation in (20c) is possible only if the onset of the third syllable is one of [r,l,s] and if the vowels of the two poststress syllables are identical):

(20) Possible grammatical structures for **σ**σσ
- a. **σ**σ] # [σ.. (separate grammatical words)
- b. [**σ**σ]- σ] (grammatical word plus clitic)
- c. [**σ**σσ] (root plus epenthetic vowel)

Thus, Selayarese listeners, unlike Huave listeners, cannot use stress to reliably demarcate words, and cannot disregard segmental material following the stress foot (indeed, such material may encode lexical contrast in Selayarese, as in *bótoro* 'gamble' vs. *bótolo* 'bottle'). Rather than simply using stress to recover native language word structure, then, Selayarese listeners must attend to both stress and segmental structure.

However, stress may function not only to demarcate words, but also to signal lexical contrasts, and we should expect listeners whose language uses stress in this way to be sensitive to foreign stress (as argued by Peperkamp and Dupoux 2002, Peperkamp 2004). In Selayarese, stress serves to distinguish epenthetic from nonepenthetic roots (as in the minimal pair *sáhala* (from /sahal/) 'profit' vs. *sahála* (from /sahala/) 'sea cucumber'), and therefore the Selayarese adapters' cavalier treatment of foreign stress is surprising. But in fact, the vast majority of words of the shape …V r,l,s V# (where the last two vowels are identical) are epenthetic forms, with antepenultimate stress (indeed, the minimal pair above may be the only one). Thus, segmental cues are in most cases sufficient for distinguishing lexical contrasts in Selayarese.

We now turn to Fijian, a language in which stress does serve as a signal of lexical contrast. However, stress is predictable from phonemic vowel length contrasts, and I will argue that vowel length, not stress, is what Fijian listeners attend to.

5. Stress Adaptation in Fijian

5.1. Stress and Length: Production Grammar Analysis

In the adaptation of loanwords in Fijian, analyzed by Kenstowicz (2003), source stress is preserved not by unfaithfulness to segments but by unfaithfulness to vowel length. Here again I will argue that the preservation of stress is not an effect of MatchStress, but rather a reflection of speakers' misparsings of the source words, guided by their perception grammar.

Fijian, like Huave and Selayarese, has high-ranked TrochaicFoot and Align-R; main stress falls on a final heavy syllable, otherwise on the penult (Kenstowicz 2003, Hayes 1995). Fijian differs from the other two languages in having only open syllables, and in having contrastive vowel length. Fijian also has secondary stress on all long vowels, and otherwise on alternating syllables leftward from the main stressed syllable. Stress is therefore dependent on vowel length, which encodes contrasts such as that between (21b) and (21c):

(21) Fijian Native Vocabulary (Kenstowicz 2003, Hayes 1995)

a. ma[káwa]	'old'
b. [màca][wá:]	'worthless'
c. [mà:][cáwa]	'week'
d. [kàmba][tá-ka]	'climb with it' (Hayes 1995, p. 144)

The requirement of a bimoraic trochee at the right edge of a word forces shortening of a vowel in penultimate position in native vocabulary:

(22) a. [síβi] 'exceed' (from /si:βi/)
b. [sì:][βí-ta] 'exceed, trans.' (Hayes 1995, p.145)

Note that lengthening the final vowel would be an alternative means of satisfying the right edge bimoraic foot requirement (*[si:][βí:]). Although this would produce an acceptable word structure (cf. *[nrè:][nré:]* 'difficult', Hayes 1995, p. 142), this option is not chosen; vowels are never lengthened in native vocabulary.

We do see lengthening, however, in loans from English. When English stress falls on the penultimate syllable, the English stressed vowel can serve either as the head of a bisyllabic foot, but a final stressed vowel must be lengthened to retain stress:

(23) English Stress Preservation

a.	pa[jáma]	'pajama'
	ta[váko]	'tobacco'
	[ò:][méka]	'omega'
	[tò:][píto]	'torpedo'
b.	ba[zá:]	'bazaar'
	qi[tá:]	'guitar'

When the English stress falls on the antepenultimate syllable, we see one of two patterns. Either the stressed vowel is lengthened, forming a foot on its own, or the final vowel is lengthened, making the antepenult the head of a bisyllabic foot:

(24) English Antepenultimate Stress:
a. [kò:][lóni] 'colony'
[tà:][féta] 'taffeta'
b. [kàli][kó:] 'calico'
[pòli][ó:] 'polio'

Thus, the English main stress vowel always receives some stress, although the main stress of the Fijian adaptation may fall on an originally unstressed vowel (as in *kò:lóni* 'colony'). Kenstowicz analyzes this complex array of data, including the different behavior of words like those in (24a) and (24b), by a ranking reminiscent of that posited for Huave: TrochaicFoot, Align-R, and MaxStress (=Davison & Noyer's MatchStress) rank above faithfulness constraints (in this case, DepMora: don't add a mora). The contrast between the patterns illustrated in (24a) and (24b) is accounted for by a constraint that minimizes the perceptual difference between source and output:

(25) PP-2: a short unstressed V may not be realized as a long stressed V

The 'colony'/'calico' patterns are derived as illustrated below. Note that it is necessary to assume that Fijians analyze the final V of 'calico' as underlyingly long, so that PP-2 allows it to be stressed:

(26) /colony/	Troch Stress, Align-R	Max Stress	Dep Mora	PP-2
☞a.[kò:][lóni]			*	
b. [kòlo][ní:]			*	*! (i → í:)
c. ko [lóni]		*!		

(27) /calico:/	Troch Stress, Align-R	Max Stress	Dep Mora	PP-2
a.[kà:][líko]			*!	
☞b.[kàli][kó:]				
c. ka [líko]		*!		

This analysis raises the same sorts of questions we have been pondering:

1. What would have caused Fijians to rank MaxStress so high?

2. Given that lengthening is never attested in native vocabulary, how do Fijians arrive at the ranking DepMora>>PP-2?

3. Why do we find an asymmetry between Fijians' interpretations of English pretonic tense vowels/diphthongs and final tense vowels/diphthongs? Kenstowicz (2003) notes that an English tense vowel before the English main stress is always realized as long (*ò:méka*, *tò:píto*), while an English tense vowel in final position may be realized as either long or short (*kàlikó:* vs. *tò:píto*, *kò:lóni*).

5.2. Stress and Length: Alternative Analysis

In Kenstowicz's analysis, Fijians perceive English stress and preserve it, by vowel lengthening if necessary. My proposal is that instead, Fijians perceive English stress as length; in parsing English words, Fijians use prominence patterns to decode phonemic length contrasts, as they must do in distinguishing Fijian words like *ma[káwa]* 'old' from words like *[mà:][cáwa]* 'week.' (See Peperkamp and Dupoux 2002 and Peperkamp 2004 for similar arguments.) A Fijian vowel may be stressed either by virtue of occupying a prominence-conferring position (head of a bisyllabic foot, that is, before an unstressed syllable), or by being long. Therefore, in Fijian, any vowel that is stressed and is not in a prominence-conferring position must be long. These representations then serve as input to the production grammar, which assigns stress according to the native language stress constraints.

Fijians hear a final stressed vowel (as in *bazá:* 'bazaar') as long because in Fijian, the only way a final vowel can achieve greater prominence than the vowel preceding it is by virtue of being long. In contrast, a penultimate stressed vowel (as in *taváko* 'tobacco') need not be analyzed as long, because it occurs in a prominence-conferring position. The variation seen in stressed antepenultimate vowels (as in *kàlikó:* 'calico' vs. *kò:lóni* 'colony' also makes sense: the Fijian grammar provides two possible routes to prominence in this position, as head of a bisyllabic foot (as in [kàli][kó:]) or as a long vowel (as in [kò:][lóni]).

The asymmetric behavior of pretonic and posttonic vowels also falls out from this account. Recall that tense prestress vowels are lengthened (*ò:méka* vs. *pajáma*), while poststress vowels may be either short or long (*kàlikó:* vs. *kò:lóni).* Apparently, Fijian speakers hear the prominence on the first vowel in 'omega' (as opposed to the first vowel of 'pajama'). According to their grammar, the only way to have two adjacent stresses is by having a long vowel. In words like 'calico' and 'colony,' which consist of a clearly prominent syllable followed by two less prominent syllables, the status of the final vowel is less clear, and the variation found here is to be expected.

We can formalize these observations in a set of constraints of the perception grammar which allow Fijian speakers to recover length by consideration of the relative prominence of vowels in a word:

(28) Fijian Perceptual Mapping Constraints:

a. FinalVLong: If final V is significantly more prominent than preceding V, then assume it is long.

b. FirstVLong: In adjacent prominent vowels, assume first V is long (that is, a stress class signals length).

c. *LongV: Assume all vowels are short.

These constraints will map English inputs 'pajama' and 'omega' to underlying representations which in turn serve in inputs to the production grammar.

(29) inputs to perception grammar: English 'pajáma', 'òméga'

	FinalVLg	FirstVLong	*LongV
☞ a. /pajama/			
b. /pa:jama/			*!
c. /pajama:/	*! (ə<á)		*
d. /pa:jama:/	*! (ə<á)		**
a. /omeka/		*! (ò,é>ə)	
☞ b. /o:meka/			*
c. /omeka:/	*! (é>ə)	*! (ò,é>ə)	*
d. /o:meka:/	*! (é>ə)		**

The perceived length of secondarily stressed vowels before the mainstressed vowel is on this account a function of FirstVLong. The constraints above can also predict the variability of vowels following the main stress (*kàlikó:* vs. *kò:lóni)* if we assume that part of the information Fijian speakers use in determining the relative prominence of vowels includes inherent length differences. As is well established, English vowels exhibit length differences independent of the increased length conferred by stress or intonation. Average durations are presented below:

(30) English V durations (Crystal and House 1988):
ɔɪ > au > ai > o > ɔ > a > ei > æ > er > u > i> ...
298 202 160 155 146 134 133 131 116 114 107...msec

'Calico' and 'colony' are similar in their prosodic structures, and in the inherent lengths of their first and second vowels. Where they differ is in the inherent durations of their final vowels, with [o] on average nearly 50ms longer than [i] (even assuming the source pronunciation had a tense final [i]). Thus the final vowel of 'calico' is longer, relative to the other vowels of the word, than the final vowel of 'colony' relative to the vowels of its own word. Evidence exists that inherent vowel length differences of this type, though not linguistically significant in English, may influence nonnative speakers. Peng and Ann (2001) have found, in Singapore English, Nigerian English, and the English of Spanish speakers, pronunciations like *illusTRAtor, frusTRAted, exerCISE, CHInese, autoBiography*. Based on a survey of such unfaithful stressings, they conclude that "If a multisyllabic word develops a primary stress placement distinct from L1, primary stress in L2 falls on the syllable whose vowel lasts the longest" (Peng and Ann 2001, page 14). We can account for the variation in forms like 'calico' and 'colony' by assuming that Fijian listeners also attend to the relative durations of vowels in a word by including one additional constraint in our perception grammar:

(31) AntepenultVLong: If antepenult V is significantly longer than all following Vs, then assume antepenultimate V is long.

(32) Inputs = English 'calico', 'colony'

	FinalVLg	FirstVLong	AntepVLg	*LongV
a. /kaliko/	*! (o>ə)		(æ ≈o)	
b. /ka:liko/	*! (o>ə)			*
☞c. /kaliko:/			(æ ≈o)	*
d. /ka:liko:/				*!*
a. /koloni/			*! (a >ə ,i)	
☞ b./ko:loni/				*
c. /koloni:/	*! (i≈o)		* (a > ə,i)	*
d. /ko:loni:/	*! (i≈o)			**

In 'colony' the initial vowel (presumably either [a] or [ɔ]) is inherently longer than the final [i], and the main stress on that initial vowel further increases the duration difference between the two vowels. But in 'calico' the initial vowel ([æ] or [a]) is inherently shorter than the final vowel [o], and stress on the first vowel will simply bring the two durations closer together.

Note that Kenstowicz's analysis would require some similar mechanism, since it is crucial to his analysis that Fijian listeners analyze the final vowel of 'calico' as long. Thus, along with the production constraint MaxStress, the production analysis contains an implicit component that identifies certain source vowels as underlyingly long. On the listener-oriented account, this component accounts as well for the lengthening of English stressed vowels, not as an effect of a mandate to maintain English stress, but rather as a misperception of English stress as a signal of underlying vowel length. The perception grammar interprets the various acoustic signals of the English form (including not only stress but also subtle differences due to inherent length, final lengthening,[5]and so forth) in order to map the English form to a representation that encodes contrastive vowel length. This representation then serves as input to the production grammar, which assigns stress according to Fijian principles.

At this point we should ask why Fijian speakers behave differently from Huave

[5]Final lengthening might explain the length of the final vowel in the adaptation of 'polio.'

speakers, since in both languages the right edges of words are invariably aligned with the main stress foot. In other words, stress in Fijian serves to signal phonemic vowel length contrasts, but also to mark the edges of words. Why, then, do Fijians not attend to stress in the same way that Huave speakers do, assuming a word boundary at the right edge of the stress foot? One possible answer is that the languages are actually quite different in the relationship between stress and word edge: while Huave appears to have one clearly perceptible stress per word, Fijian has a rich system of secondary stress which makes the strategy of projecting word edges after stressed syllables a risky one.

We must also consider an additional argument that the production grammar of Fijian speakers preserves the English stress position. Kenstowicz discusses words like *[tále]vi[sóni]* 'television' which, in contrast to the native form *li[námu][nráu]* 'arm-2dual possessor' (Hayes 1995, page 144), allows two adjacent unstressed syllables. The possibility of stress lapse is, Kenstowicz argues, in conflict with the native language grammar, and therefore can only be explained as a function of the stress conserving constraint. However, the native grammar does have forms with stress lapse (such as *[báti]ka[sívi]* 'kind of fish'), and as Kenstowicz (2003, page 9) notes: "To the extent that these items are no longer decomposed in the minds of Fijian speakers, there is a precedent for the lapses observed in loans." It seems likely, then, that the foot structure of longer words containing strings of light syllables is to a large extent lexicalized, which means that speakers will listen for such footing in new words. The reasonable interpretation of the footing of the first two syllables of 'television' is as a bisyllabic foot.[6]

6. Conclusion

One great virtue of the Optimality Theoretic approach is that it forces us to ask not only whether a grammar is consistent with a set of data, but also how that grammar could have been learned. In the cases discussed above, asking this question has led us to consider alternative analyses of the data. I have considered three cases of loan adaptation which have been described in terms of different rankings of constraints on faithfulness to source stress. In two languages, Huave and Fijian, source stress is preserved, while in Selayarese, stress may be repositioned to conform to native language stress constraints. We can view that the Huave preservation of source stress as a function of Huave listeners' missegmentation of words, due to the exceptionality of final stress in their native language, and the Fijian source stress preservation as a byproduct of the identification of stress with length.

Our larger conclusion is that what at first appeared to be unlearnable rankings in the production grammar are actually a reflection either of input frequency or of the workings of a perception grammar. This approach has several desirable consequences. First, we can eliminate loan-specific constraints like MatchStress from the grammar. This in turn allows

[6]Space limitations preclude discussion of the role of epenthetic vowels in Fijian stress adaptation; see Kenstowicz 2003 for an analysis of these facts.

us to make much stronger predictions about the range of possible adaptation patterns. For example, a model that includes a MatchStress constraint in the repertoire of production grammar constraints predicts that all combinations of native stress system and stress conservation in loanword adaptation should be logically possible, due to free ranking of MatchStress. In contrast, a model such as the one proposed above ties the treatment of stress in loanwords to the function of stress in the native language. We would not expect, for example, to find a language that is like Huave in all respects except that it ranks MatchStress low.

The next question that must be asked, however, is how rankings in the perception grammar are learned (and indeed, what the universal set of perception constraints might be). While such a question is far beyond the scope of this paper (see for example Boersma 1998, Pater 1998, Silverman 1992, and others for proposals), we can outline a model in which similar processes underlie the acquisition of rankings in both the perception and the production grammars:

(33) Dual Model of Acquisition

a. Production Grammar: maps underlying representations to surface representations.
Consists of M constraints, which discourage contrast in SRs, and F constraints, which support contrast in SRs.
Initial ranking is M>>F, giving the most restrictive grammar consistent with the data; reranking occurs in response to evidence for contrast in input data.
Final ranking allows speaker to produce all contrasts necessary for native language.

b. Perception/Parsing/Decoding Grammar: maps the acoustic signal to underlying phonological representations which serve as input to the production grammar.
Consists of M constraints, which discourage contrast in URs, and F constraints, which support contrast in URs. (For example, high-ranked AssumeWordEdge suppresses contrast between VC]VC# and VCVC]#.)
Initial ranking is M>>F, giving smallest number of contrasts consistent with the data; reranking occurs in response to evidence for contrast in input data.
Final ranking limits possible UR contrasts to those supported by NL data (i.e., base is not fully rich).

There is obviously much work to be done in developing a complete model of native language perception/decoding processes, but language contact phonology is potentially a rich source of insights into this aspect of language..

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Department of Linguistics
Stony Brook University (SUNY Stony Brook)
Stony Brook NY 11794-4376

ellen.broselow@stonybrook.edu